

---

**Section 206**  
**Flood Plain Management Services**

---

**100-Year Flood Elevation Determination-**  
**Lake Hebron**  
**Monson, Maine**

**November 1996**



**US Army Corps**  
**of Engineers**

**New England Division**

REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.				
1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE NOVEMBER 1996		3. REPORT TYPE AND DATES COVERED FINAL REPORT
4. TITLE AND SUBTITLE  100-Year Flood Elevation Determination - Lake Hebron, Monson, Maine			5. FUNDING NUMBERS	
6. AUTHOR(S)  US ARMY CORPS OF ENGINEERS NEW ENGLAND DIVISION				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) US ARMY CORPS OF ENGINEERS NEW ENGLAND DIVISION 424 TRAPELO ROAD WALTHAM, MA 02254			8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) US ARMY CORPS OF ENGINEERS NEW ENGLAND DIVISION 424 TRAPELO ROAD WALTHAM, MA 02254			10. SPONSORING/MONITORING AGENCY REPORT NUMBER	
11. SUPPLEMENTARY NOTES  Section 206 of the 1960 Flood Control Act (Public Law 86-645)				
12a. DISTRIBUTION AVAILABILITY STATEMENT  Approved for public release, distribution unlimited			12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words)  The State of Maine's State Planning Office requested the Corps to determine the 100-year flood elevation for Lake Hebron. This report presents the hydrologic and hydraulic information pertinent to determining this elevation.				
14. SUBJECT TERMS  Lake Hebron, 100-Year Flood Elevation			15. NUMBER OF PAGES	
			16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT  UNCLASSIFIED	18. SECURITY CLASSIFICATION OF THIS PAGE  UNCLASSIFIED	19. SECURITY CLASSIFICATION OF ABSTRACT  UNCLASSIFIED	20. LIMITATION OF ABSTRACT	

100-YEAR FLOOD ELEVATION DETERMINATION  
LAKE HEBRON  
MONSON, MAINE

TABLE OF CONTENTS

<u>Paragraph</u>	<u>Subject</u>	<u>Page</u>
1	PURPOSE AND SCOPE	1
2	DESCRIPTION OF STUDY AREA	
	a. General	1
	b. Lake Hebron	2
3	STREAMFLOW	3
4	HISTORY OF FLOODING	
	a. General	3
	b. March/April 1987	3
5	DISCHARGE FREQUENCIES	4
6	HIGH FLOW DURATION FREQUENCY ANALYSIS	4
7	STUDY PROCEDURES	
	a. General	5
	b. HEC-1 Storage Routing	5
	c. HEC-2 Backwater Analysis	6
	d. Results	6
8	SUMMARY	7

LIST OF PLATES

<u>Plate</u>	<u>Title</u>
1	Penobscot River Basin Map
2	Lake Hebron Photos
3	Lake Hebron Topographic Map
4	Adopted 100-Year Hydrographs
5	Lake Hebron Discharge Rating Curve

100-YEAR FLOOD ELEVATION DETERMINATION  
LAKE HEBRON  
MONSON, MAINE

1. PURPOSE AND SCOPE

This report presents hydrologic information and analysis pertinent to the investigation of the 100-year flood elevation of Lake Hebron, within the town of Monson, Maine. The 100-year lake elevation may be used by the State and affected communities in regulating future development. This study was conducted by the Corps of Engineers Section 206 Flood Plain Management Services (FPMS) Program, at the request of the State of Maine, Planning Office, and was performed by the New England Division. Included are sections on basic description, streamflow, history of flooding, flood frequencies, and study procedures.

Lake Hebron, located in the Penobscot River Basin, is at approximately latitude 45°17' N., and longitude 69°30' W. in the county of Piscataquis, Maine, and is a tributary to Monson Stream at Monson, Maine. The lake has a large impoundment with a surface area of 1.02 square miles, controlled by a spillway located in and owned by the town of Monson, and is shown on plate 1.

2. DESCRIPTION OF STUDY AREA

a. General. The drainage area of Lake Hebron is 5.06 square miles. The watershed is very sparsely developed woodland, and contains some mountainous terrain, including Buck Hill with a peak over 1,500 feet NGVD (National Geodetic Vertical Datum of 1929), whereas the elevation of Lake Hebron is 845 feet NGVD. Lake Hebron has a considerable sized surface area compared to its drainage area; therefore, there is considerable surcharge storage at the lake. Due to this hydrologic characteristic, peak flows and flood elevations of the lake are more a function of volume of storm rainfall runoff and/or snowmelt rather than peak rate of runoff.

Only minor unnamed tributaries flow into Lake Hebron. The outflow from Lake Hebron flows in an easterly direction for a distance of two miles to the confluence with Monson Stream, then flows in a southeasterly direction for two miles to the confluence of Davis Brook. This Brook then flows in a northeasterly direction for about 2.5 miles into Big Wilson Stream, which eventually drains into Sebec Lake. From Sebec Lake, the Sebec River flows easterly to the confluence of Piscataquis River in Derby, Maine.

b. Lake Hebron. The watershed area of Lake Hebron consists of mountainous terrain with relatively short steep tributaries discharging into the lake. The entire lake is located in Monson. The outlet to the lake consists of flow under Main Street through an 8-foot wide by 5-foot high concrete box culvert, with Main Street acting as a dam embankment. This culvert, approximately 45 feet long, carries water under both Main Street and a Museum building. From this culvert, water flows 70 feet downstream in an open channel to the spillway. The spillway is 13-feet long with a crest elevation of 844.8 feet NGVD. The upstream side of the Main Street culvert is equipped with a trashrack and stoplog slots. However, according to the town, the stoplogs are no longer used to control the lake level. Normal pool elevations are maintained by flow over the spillway. Photos of the spillway and outlet area are shown on plate 2.

According to the town manager, the original dam/outlet area was constructed in the late 1940s by private interests for fire line purposes at a local gristmill and is now owned by the town. The lake provides flood modification to downstream areas through surcharge storage. The lake has a surface area of about one square mile (652 acres); therefore, one foot of surcharge storage would be equivalent to 2.4 inches of runoff from the contributing watershed. Pertinent data on the lake and dam are listed in the following tabulation:

PERTINENT DATA  
LAKE HEBRON  
MONSON, MAINE

DRAINAGE AREA	5.06 square miles
SURFACE AREA	652 acres
SPILLWAY	
Elevation	844.8 feet NGVD
Length	13 feet
Type	Ungated ogee weir
OUTLETS	None

The existing shoreline development of Lake Hebron is generally sparse, with segments of dense development near the outlet on the east side. The northern and southern shorelines also have areas of dense development near the center of the lake. The western part of the lake has sparse to no development. Development can be seen on the topographic map shown on plate 3. The entire shoreline is located in the town of Monson. The main highway access route is the combined State Routes 6 and 15 (also known as Main Street through Monson), which runs in an north-south direction on the east side of the lake over the outlet area. The shoreline is accessible through many local and private roads.

### 3. STREAMFLOW

There are no streamflow gaging stations for flow into or out of Lake Hebron. The U.S. Geological Survey (USGS) has recorded flows since 1903 of the nearby Piscataquis River at a gage (#01031500) near Dover-Foxcroft, Maine. Drainage area at the gage is 298 square miles. The long term hydrologic record near Dover-Foxcroft was used for reference in the hydrologic analysis for Lake Hebron. Also used for reference, was the USGS gaged record on the Carrabassett River near North Anson, Maine. The Carrabassett gage (#01047000), located in the adjacent Kennebec River basin, has a drainage area of 353 square miles, and a period of record from 1902 to 1907 and 1925 to present.

### 4. HISTORY OF FLOODING

a. General. Though floods can occur any season of the year at Lake Hebron, it is probable that most high flows have occurred as a result of high volume spring runoff rather than high intensity rainfall. Flooding on the nearby main stem Piscataquis River (likely to have occurred at the same time as flooding at the lake) has occurred in May 1923, March 1936, November 1950, November 1966, December 1973, April 1979, April 1983, and March/April 1987. The largest recorded flow at Dover-Foxcroft was 37,300 cfs, occurring in April 1987. Prior to the March/April 1987 event, the November 1966 event was the greatest known historic flood on the Piscataquis.

b. March/April 1987. This event was the result of approximately four inches of rainfall and accompanying snowmelt, occurring on the last day of March and first day of April. The rainfall was preceded and followed by several days of daytime temperatures in the fifties and sixties. The resulting runoff produced the largest known flood on the Piscataquis River. The recorded peak flow near Dover-Foxcroft was 37,300 cfs occurring on April 1.

## 5. DISCHARGE FREQUENCIES

Peak discharge frequencies were developed for the Piscataquis River by analysis of flow records at the USGS gaging station near Dover-Foxcroft, Maine. The gage near Dover-Foxcroft has a drainage area of 298 square miles and a period of record from 1903 to 1994 (92 years). The Corps of Engineers HEC-FFA Flood Frequency Analysis computer program was used to analyze the systematic record. The data was analyzed in a log Pearson Type III distribution, resulting in mean log 3.9222, standard deviation of 0.2119, and adopted skew of +0.30 (regional skew). The resulting computed 1 percent chance peak flow at the gage is 28,900 cfs. This peak flow was used as reference in the analysis of Lake Hebron.

## 6. HIGH FLOW DURATION FREQUENCY ANALYSIS

Lake Hebron's surface area comprises 20 percent of its drainage area. This considerable sized surface area produces a significant amount of surcharge storage. The peak stage of Lake Hebron is considered more a function of runoff volume than peak rate of watershed runoff. Therefore, a high flow duration frequency analysis was performed for two gaged watersheds in the vicinity of Lake Hebron to determine runoff volume frequency relationships.

High flow duration frequency analyses were performed for the Piscataquis River near Dover-Foxcroft and the Carrabassett River near North Anson gages, using the USGS Watstore computer program. We note that the long term records for both stations included the 1936 and 1987 flood events, which produced significant runoff volumes. From these analyses, the 1 percent chance (100-year) runoff volumes could be estimated for inflow to Lake Hebron.

The estimated 1 percent chance runoff volumes for inflow to Lake Hebron were based on the gaged analyses, and on a comparison between the hydrologic conditions of the gaged watersheds to those of the Lake Hebron watershed. The watershed upstream of the lake has no regulation and minimal natural storage, characteristics similar to those of the nearby Piscataquis and Carrabassett River watersheds. The 100-year 1-, 3-, and 7-day runoff volumes for the Piscataquis River are 2.9, 5.7, and 8.5 inches (of depth over the watershed), respectively. The runoff volumes for the Carrabassett River are generally the same. The 1-, 3-, and 7-day runoff volumes for the Carrabassett River near North Anson are 3.1, 5.7, and 9.5 inches, respectively.

Based on hydrologic engineering judgement, the 1- and 3-day runoff volumes of the two gages may be somewhat lower than those expected at Lake Hebron, due to differing hydrologic conditions. The size of the gaged drainage areas are much larger than the Lake Hebron watershed area. The larger watershed gaged areas provide somewhat more natural storage and initial runoff losses. No losses will be incurred to rain falling directly on the Lake Hebron water surface, which is 20 percent of the drainage area.

Based upon the above discussion, a 1 percent chance (100-year) inflow hydrograph to Lake Hebron was estimated by adopting appropriate 1-, 3-, and 7-day runoff volumes, and by adopting a peak inflow (drainage area ratio of Piscataquis River 100-year peak). The shape of the inflow hydrograph was based on hydrologic engineering judgement and analysis of experienced hydrograph data at the gage. The resulting adopted 1-, 3-, and 7-day volumes were 3.5, 6.1, and 9.0 inches, respectively. The adopted lake inflow hydrograph can be seen on plate 4.

## 7. STUDY PROCEDURES

a. General. As mentioned previously, Lake Hebron has a large surface area compared to its drainage area. One foot of surcharge storage is equivalent to 2.4 inches of runoff from the watershed; therefore, reservoir storage routings were performed to determine the 1 percent chance peak elevation of the lake. Based on the input data, the HEC-1 computer program was used to conduct storage routing to determine the outflow hydrograph and corresponding pool elevations.

b. HEC-1 Storage Routing. The Corps of Engineers HEC-1 computer model was used to compute reservoir storage routings. Storage routings are based on the continuity equation (inflow = outflow + change in storage). Input for the model consisted of storage characteristics for the reservoir, inflow hydrograph, and reservoir discharge characteristics.

The adopted 100-year inflow hydrograph to Lake Hebron was developed by a combination of high flow duration frequency analysis, and estimated peak flow, as previously stated. Area-capacity relationships were determined from the calculated surface area of the reservoir at normal pool (elevation 845 feet NGVD), and the next contour line above the reservoir level, from USGS Quad sheets (1:24000, 20-foot contour interval). Discharge ratings of the outlet to the lake were developed by combination of spillway discharge rating using the weir equations, along with hydraulic losses expected through the culvert under Main Street. Spillway discharge ratings were developed using the weir equation



with adopted weir flow coefficients of 3.1 for the spillway, and slightly lower values for the left and right overflow areas. Dimensions were field measured. The spillway has a length of 13 feet with a crest of 844.8 feet NGVD. The spillway only rating is based on flow over the spillway, including flow over the abutments when levels exceed the height of the abutments. Hydraulic losses through the culvert under Main Street were computed using HEC-2 backwater analysis.

c. HEC-2 Backwater Analysis. The Corps of Engineers HEC-2 computer model was used to aid in developing the outlet rating of the lake. It is a standard step method for calculating water surface elevations for steady gradually varied flows, based on river geometry and structures crossing the channel. Input for the model consists of channel geometry, hydraulic roughness coefficients, bridge elevation data and structural geometry, and flow data. Dimensions of the culvert under main Street and channel information at the outlet to Lake Hebron were field obtained for input to the model.

The HEC-2 backwater analysis was needed to determine the hydraulic losses expected through the culvert under Main Street, and determine its effects on the outlet rating. The HEC-2 backwater analysis was started at the spillway with a known rating and modeled upstream to the upstream side of the Main Street culvert, to determine the hydraulic control for the lake. Multiple flows were used to develop an outlet rating curve for the lake.

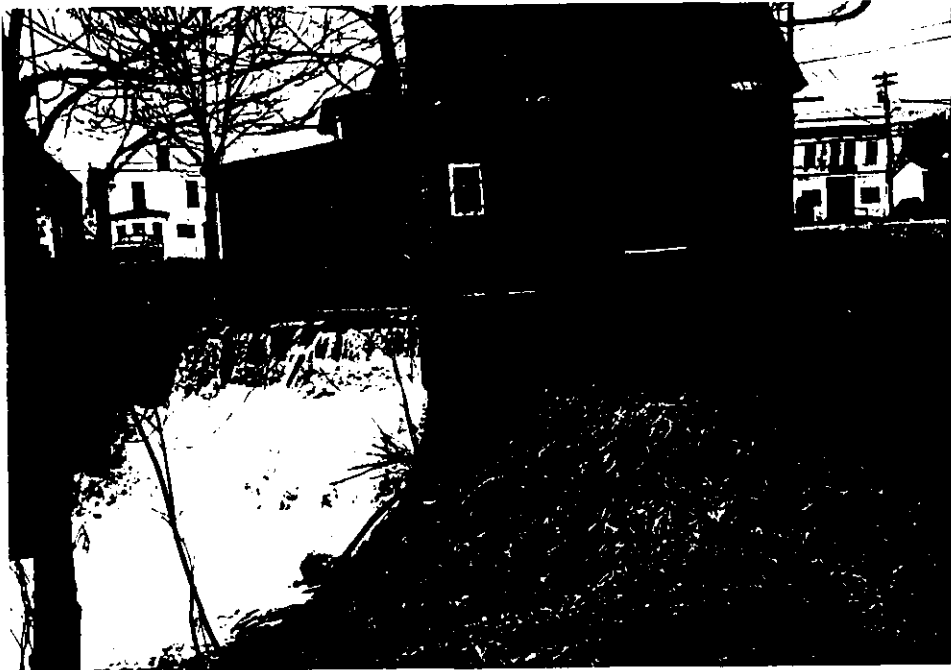
Analysis of the backwater results indicate that control for Lake Hebron is the spillway until lake elevations exceed 847.5 feet NGVD when the culvert under Main Street affects the outlet rating, due to hydraulic losses because of pressure flow through the culvert. The adopted Lake Hebron outlet rating curve is presented on plate 5. The developed outlet rating assumes no major obstructions due to debris or ice jams, either or which could result in higher reservoir levels.

d. Results. The adopted 100-year inflow hydrograph was routed through Lake Hebron, assuming starting pool was at spillway crest. There are no gates or other low level outlets; therefore, it is considered reasonable to start the analysis with the reservoir level at spillway crest. The corresponding routed 100-year peak pool elevation is 846.8 ft NGVD, and the peak discharge is 120 cfs. Inflow and outflow hydrographs, as well as reservoir pool levels, are shown on plate 4.

## 8. SUMMARY

The 100-year flood elevation for Lake Hebron was determined to be 846.8 feet NGVD, or for regulating purposes, 847 feet NGVD (National Geodetic Vertical Datum of 1929). This elevation is 2.2 feet above the spillway crest elevation of 844.8 (normal pool elevation). This elevation was determined by adopted inflow hydrographs, storage characteristics of the lake, and discharge characteristics of the spillway, along with the hydraulic losses expected through the culvert under Main Street. In determining the elevation, it was assumed that the reservoir level was at spillway crest at the start of storage routings of the event, and that the culvert at the lake outlet was free flowing (i.e. not blocked by debris). It is noted that the analysis undertaken did not consider the potential effects of ice jams on flood levels. Based on the adopted inflow hydrograph and storage routing, the actual computed 1 percent chance (100-year) elevation at the lake would be 846.8 feet NGVD.





OUTLET SPILLWAY



OUTLET AREA: CULVERT IS UNDER MAIN STREET AND D/S OUTLET IS UNDER MIDDLE BUILDING

(Note: Lake is in background and spillway is to the left of the photo)

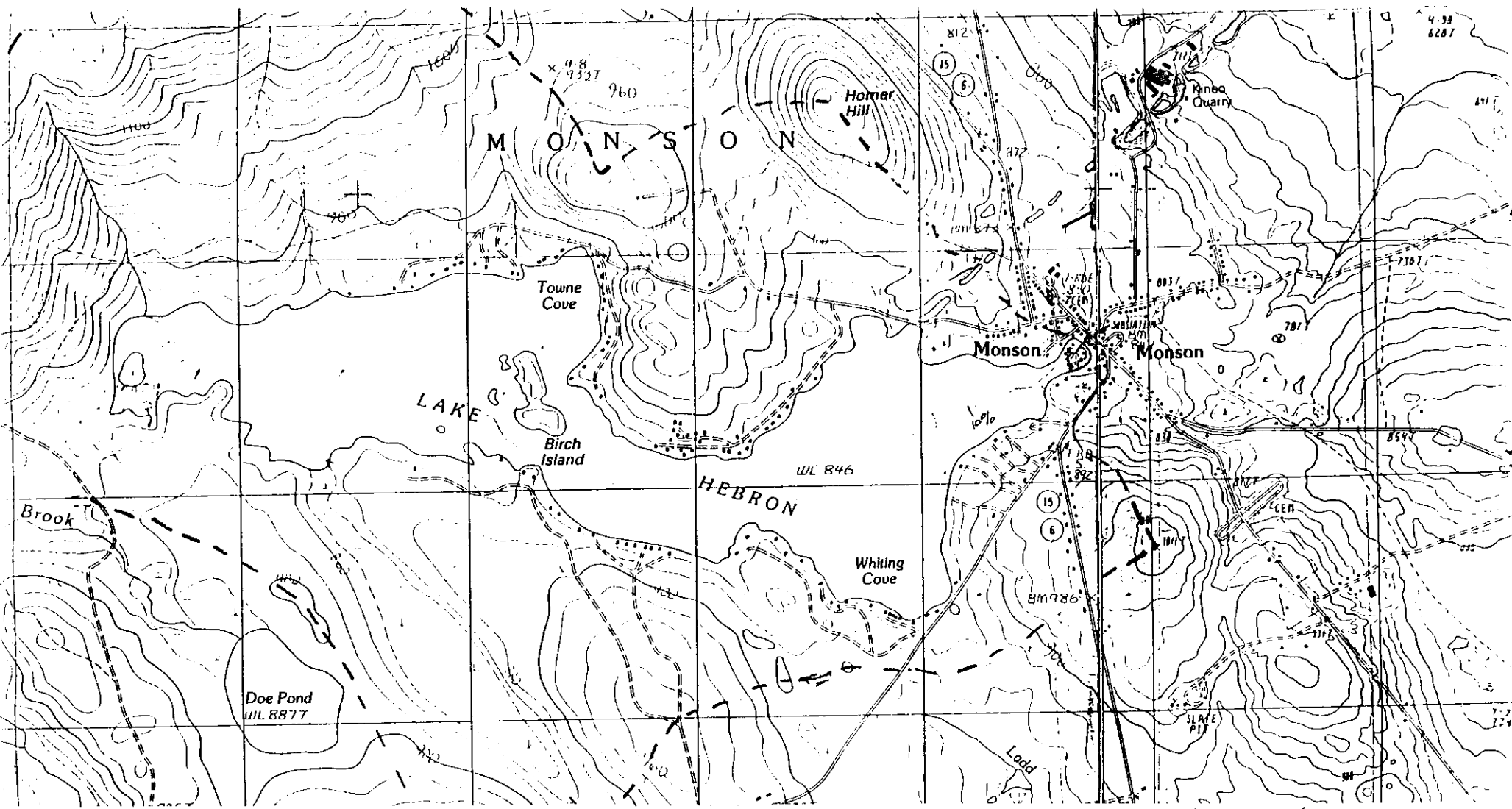
LAKE HEBRON

Monson, ME

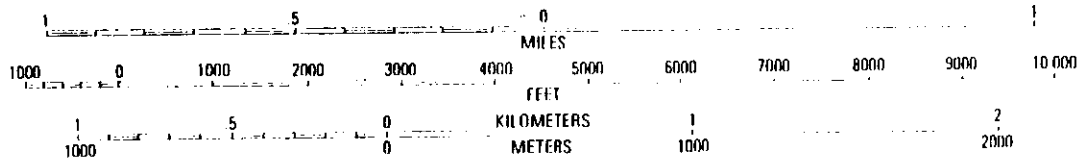
PHOTOS

HEB

SEP 1996



SCALE 1:24 000



CONTOUR INTERVAL 20 FEET

To convert feet to meters multiply by .3048  
To convert meters to feet multiply by 3.2808

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS  
FOR SALE BY U. S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225, OR RESTON, VIRGINIA 22092

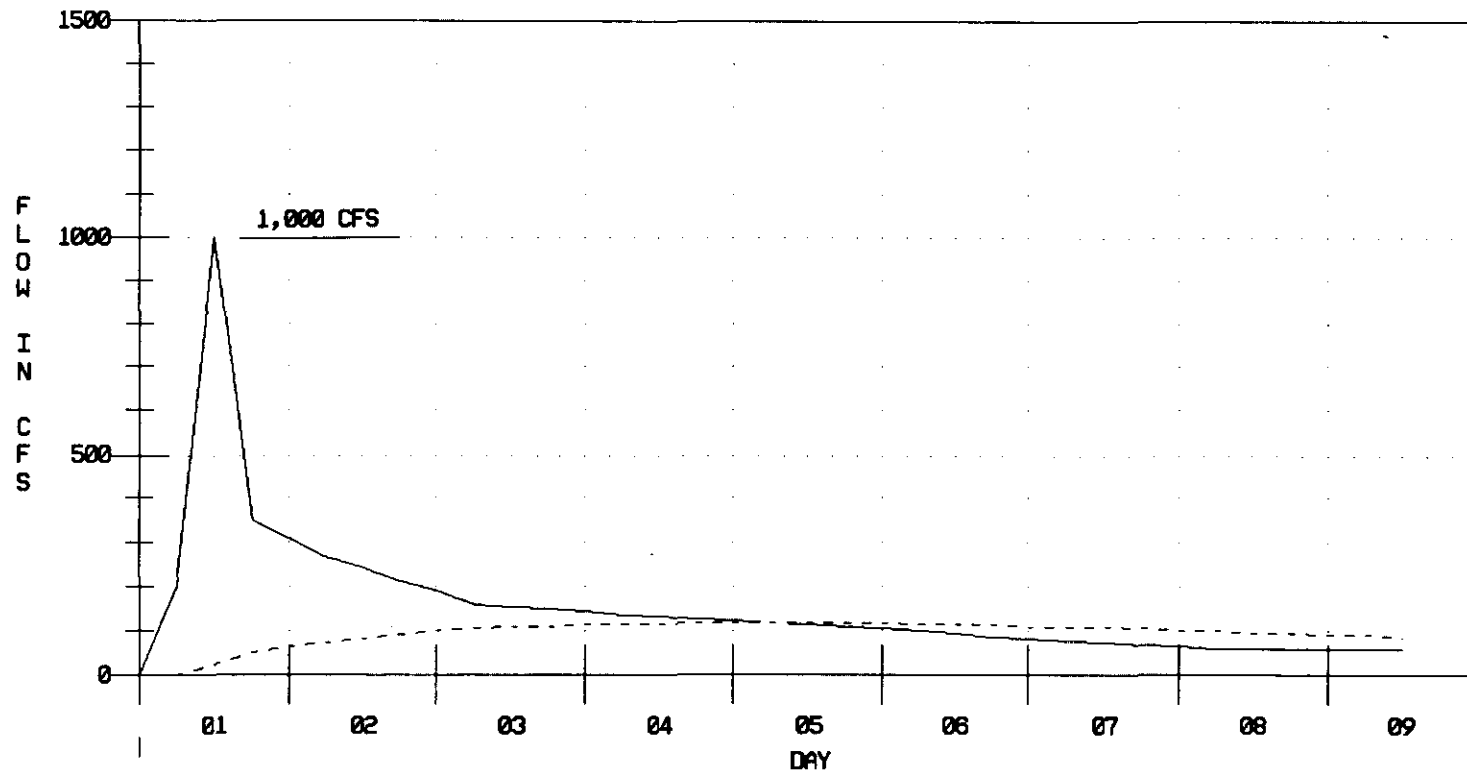
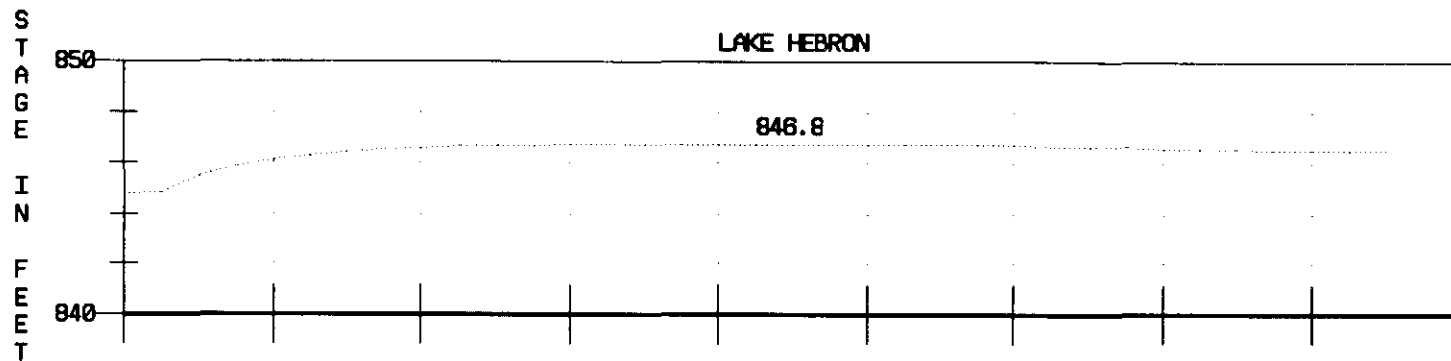
MAINE

LAKE HEBRON  
Monson, ME

TOPOGRAPHIC MAP

HEB

SEP 1996



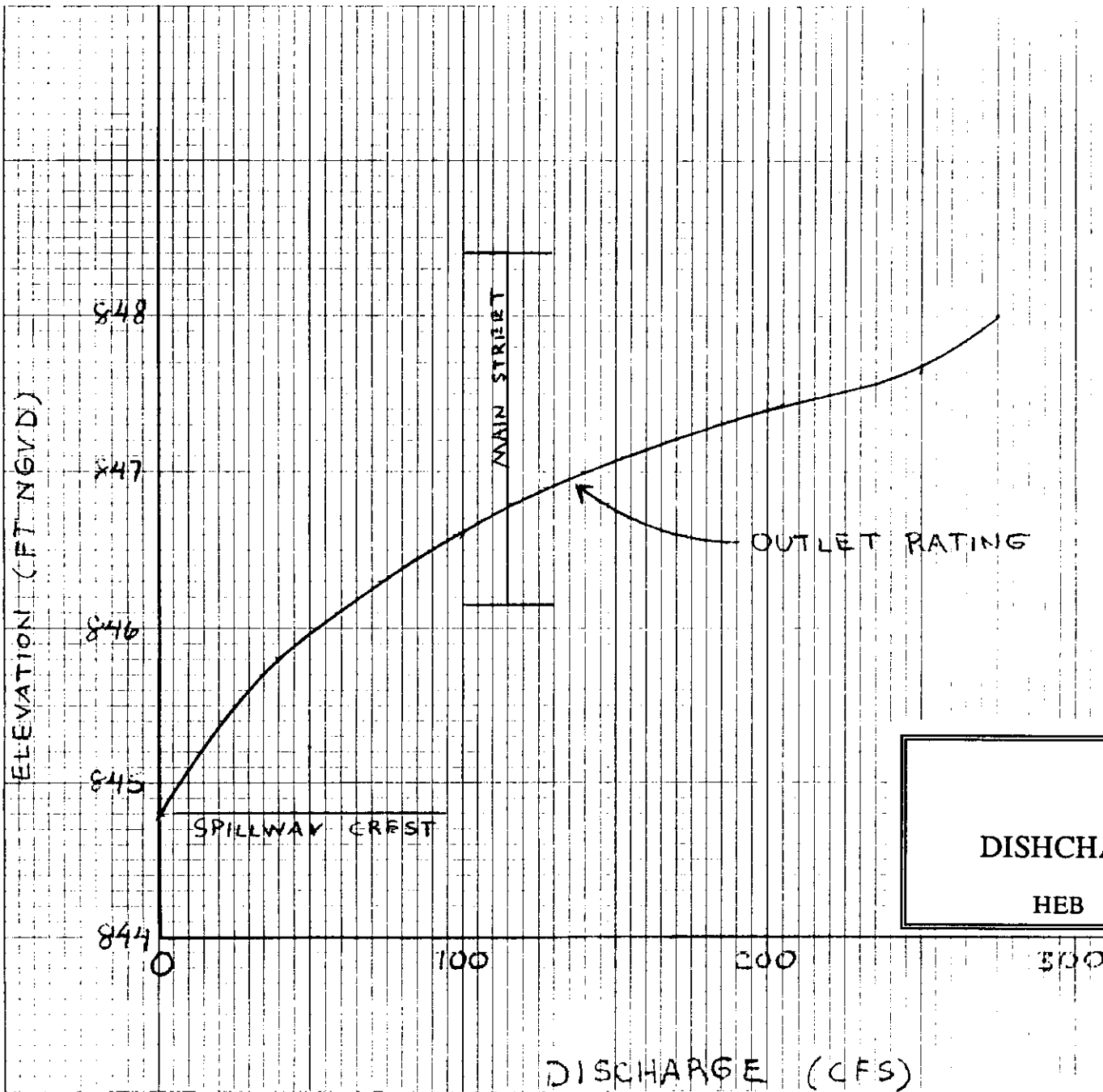
— ADOPTED 100-YEAR INFLOW HYDROGRAPH  
 - - - 100-YEAR OUTFLOW HYDROGRAPH  
 ..... LAKE ELEVATION (STAGE IN FEET NGVD)

LAKE HEBRON  
Monson, ME

ADOPTED 100-YEAR HYDROGRAPHS

HEB

SEP 1996



LAKE HEBRON  
Monson, ME

**DISCHARGE RATING CURVE**

HEB SEP 1996